Engineering News

Tribune Building, New York City.

GEO. H. FROST, Proprietor.

SATURDAY, AUG. 20, 1881.

A typographical error occurred in the first proposal on page viii. of the issue of last week. The city should have been Sharpsville, Pa., and not Shreveport. As will be seen by this issue, the time for receiving bids in this advertisement has been changed to August 27.

The Vienna *Neue Freie Presse* gives a very long and interesting account of the experiments made of the new blasting system of Capt. Lang, an Austrian engineer. The great hindrance to navigation on the Danube, the Austrian Hell Gate, is the mass of rock which has been known for ages as the Iron Gate. Lang's system consists in placing small charges, if such they can be called, not in, but on the rock, and at the depth of some six feet. Hundreds of charges can be exploded within a short time, and without any danger to the workmen. The experiments were eminently satisfactory; some sixty cubic meters of rock were disintegrated, and the general opinion of the engineers present was that the old system of boring had been superseded. The charges are of course fired by electricity. The current of the water is immaterial, no extensive preparations are required, and thus we may hope that a very great progress has been achieved in this branch of engineering, and this in a simple way. When we receive the reports from the Austrian Engineer's Society we shall translate it for our readers.

PERSONAL.

Mr. E. R. Howe, of Boston, Mass., has been appointed manager and superintendent of the Brittenstens Silver Mining Company—the mines lying about three miles from St. Elmo, up Grizzly Gulch. His headquarters are at St. Elmo, Colorado.

On account of a severe cold contracted while on the convention trip to Canada in June, the proprietor of this journal has been unable to attend to the business of the paper for some weeks past, and he is spending the present month at Saratoga, to which resort he is recommended by his physician in hopes of being benefited by the waters there. He expects to return by Sept. 1st, and in the meantime the consideration of matters demanding his personal attention will be somewhat delayed. At last accounts Mr. Frost had gone to the Adirondacks.

FORMULAS OF RESISTANCE.

We translate from the report of the last meeting of the Paris Society of Civil Engineers an interesting discussion of the formulas which have been introduced by a German authority, Dr. Weyrauch, Professor at the Stuttgart Polytechnic. The pamphlet was translated into English, when the Secretary of the London Society sent a copy to the Paris Society with a request for the opinion of the French school on the formulas. M. Tresca, who brought forward the subject, stated that the French system was, not only to determine the limit of rupture, but also the weight which corresponds to the limit of elasticity, as well as the elongations which correspond to those two criterions of materials. As a general thing, we build so that the construction may offer every reasonable stability, and in doing so we base our practical co-efficients on a figure of resistance which is calculated from the limit of elasticity. In England and Germany, however, the point of departure for this determination is deducted from the co-efficient of rupture. Naturally, as in both systems an excess of safety is aimed at, we have to correct the load (?) as to the limit of elasticity, or the limit of rupture, by a co-efficient which will be a guide for finding the practical limit or load. By both systems we come to about the same practical limit. To show the different stand point: Let us suppose a breaking load of 3,500 kilos per square centimeter. The English will take the fifth of this limit as a practical strain. We, on the other hand, would, in case of irons resisting 12 kilos without injury to their elasticity, take two-thirds or half the figure—say 8 kilos. Thus in the one system one-fifth has to be taken of the breaking load, while our co-efficient of one-half or two-thirds will be sufficient. Our method of reasoning is more direct, as we keep closer to the question. But still the work of Herr Weyrauch is very important. To-day, however, I shall only consider the questions of extension and compression, which serve as a basis for all others. At the beginning of his treatise he says: "In the selection of the weights or strains to which iron and steel may be exposed, the point of comparison is in relation to the weight which corresponds either to the limit of elasticity or of rupture. The new method adopted by the German engineers is based exclusively on the breaking load. There is no representative of the other school among German writers, although the practical limit is always inferior to that which would injure the elasticity." This opinion is not held, however, in France, and here is the divergence. The German engineer reasons from limits of strains which are different from ours. The new method is based altogether on the resistance to rupture. But, when we use iron, wood or metal, we reproach ourselves, and very justly, for only considering one of the qualities of those materials. It is the *ensemble* we must look at, although I have just stated that the limit of elasticity is more practical than that of rupture. The notations of the German pamphlet are different from ours, and in some cases contradictory. The weight which a material will bear in a given case, without rupture, is represented by a; but this weight must vary according to circumstances, and it is said to be the function of an indeterminate number of conditions, which may be designated by the variables, $x\ y\ z$, and then we have:

$$a = f(x\ y\ z).$$

Here a is the principal variable, while we generally consider this quantity as permanent, or at least constant, for each nature of materials. a is therefore a variable quantity, and will be represented by different notations according to the cases. All the following indications refer to the square centimeter. The writer calls t the limit of rupture per square centimeter, when the weight is put on without precipitation. It therefore represents the weight of rupture in the static state. The German writer then introduces two other co-efficients of rupture. He represents by u the weight under which an object might break if this weight u per square centimeter was put on, and taken away successively, a certain number of times, and the experiments of Woehler have proved that an object will break under successive loads of far less weight than that under static resistance.

The most interesting matter in the pamphlet is just this distinction which is shown between limits of static rupture and those of repeated loading and unloading.

The author then brings forward another resistance, which he designates by s, and which would be the breaking load, in case, after having loaded a bar with this weight s per square centimeter, and then after loading in the contrary direction to the same limit, and so on, alternately, we should also rupture it. There are thus three co-efficients of breakage to be considered: t, which would be the static weight of breakage; u, which is called the natural weight of breakage, and s, the weight which determines breakage by alternation.

This undoubtedly complicates the question, but the three ideas are of interest, and we shall see whether this complexity brings with it in certain cases a more exact knowledge of the resistant properties of materials.

It was shown by the careful experiments which were carried on by M. Woehler from 1859 to 1870, that the weight u is notably smaller than that of the weight t, but it is not so well proved that there is any considerable difference between the weight u and the weight s. In fact, we have very few figures bearing on the matter. But there need be no hesitation in admitting that if an intermittent weight can cause the breakage of an object more quickly than a permanent weight, an alternative weight must evidently cause the rupture still more rapidly. The author calls the consideration of those three limits, the weight of vibration, and on this are based the formulas of resistance of materials which have been in use in Germany since the experiments of Woehler.

The more important of those formulas are those which have been proved in practice; and the one which is most directly based on the experiments of Woehler is that which is indicated in the table as the formula of Launhardt. This formula, which might be regarded as reasonable when the series of equations from which it is deducted is gone through, is really empiric, or at least obtained by method of analysis to which we are not accustomed.

Let me suppose an object, which is at one time loaded with a weight a, and at another with a weight a'. We may represent the difference between the two weights by d, when we have:

$$d = a - a'$$
$$a = d + a'$$

These two relations may be considered as the general formulas in which there will be occasion to bring in the different values u, t and s, which we have just been considering.

If, in fact, we make $a' = 0$,

We have from the second of these formulas:

$$a = d = u$$

If $d = 0$, which means that the moduli are always the same, we should have: $a = a' = t$.

I follow as closely as I can the reasoning of M. Launhardt. He says a, the variable modulus of rupture, according to circumstances, ought to be a function of d, and he writes:

$$a = fd$$

Thus, admitting that to obtain the value of a all we have to do is to find out the value of f considered as a linear factor, M. Launhardt says that he knows the value of f in a particular case. In fact, when we have $d = 0$, he knows that $a = d$ And it is evident that here we must give to f an infinite value. There is still another case in which this value of f is known, viz.: When d is equal to a. We have then:

$$a = df \text{ and } f = 1.$$

Not only must the co-efficient, whatever it may be, satisfy the value a in those two, but also in all other conditions. Nevertheless Launhardt states that he has found a formula which fulfills those two fundamental conditions, and he writes:

$$a = \frac{t-u}{t-u}(a-a').$$

It will thus be seen how much empiricism there is this equation.

This formula,

$$a = \frac{t-u}{t-a}(a-a'),$$

he has partially solved in its relation to a, and he finds:

$$a = \frac{t-u}{t-a}(a-a') = u\left(1+\frac{t-u\,a'}{u\,a}\right).$$

Here we have a perfectly regular algebraic trans-

formation. To use this formula we have sometimes to consider the limit a, sometimes that of a'. It will happen that $\frac{a'}{a}$ being nothing else than the relation between the two quantities a' and a, a relation which we will represent by φ.

We have $a = u\left(1 + \frac{t-u}{u}\varphi\right)$.

This is the first formula in the pamphlet, and he has been directly verified by the experiments of Woehler, as shown by the following figures expressed in German measures.

	a' =	0	250	400	600	1100
a calculated by the formula of Launhardt	=	500	711	800	900	1100
a deduced from the experiments of Woehler	=	500	700	800	900	1100

The agreement could not be more complete.

If we apply ourselves this formula to an iron which, under the name of Phoenix iron, was experimented on by Woehler, we find:

$$\frac{t-u}{u} = \frac{3{,}290 - 2{,}190}{2{,}190} = \tfrac{1}{2}$$

and

$$a = 2{,}170\,(1 + \tfrac{1}{2}\,\varphi)$$

But to obtain the value of the practical limit b, we must make a certain reduction from the breaking load. We will take $u = 2{,}100$, and reduce this number to a third of its value, which gives:

$$b = 700\,(1 + \tfrac{1}{2}\,\varphi)$$

The formula of Launhardt is pretty generally adopted in Germany, but that of Dr. Weyrauch has not been consecrated by experience. As we see in the second part of the table, a represents the positive strain exercised in one sense, and a' represents the strain of compression opposed to the strain of extension. The difference would be d, and the formula

$$d = a + a',$$

will become:

$$a = d - a',$$

If $a' = o$

$$a = d = u$$

If $a' = a$

$$a = \frac{d}{2} = s.$$

s is the particular co-efficient which is termed the load of rupture from vibration; supposing that a is the function of d, we have only to determine the value of f. The factor f should, as precedently, satisfy those two particular conditions.

The formula of Weyrauch is logical, so far as it rests on good interpretation, but it is completely empiric, so far as its form is concerned. We have:

$$a = fd$$

which for $f = \frac{u-s}{2u-s-a}$, a value

which satisfies $f = 1$ for $a = u$, and $f = \frac{1}{2}$ for $a = s$, and leads successively to:

$$a = \frac{u-s}{2u-s-a}(a + a')$$

$$a = u\left(1 + \frac{u-s}{u}\varphi\right)$$

φ being here a negative quantity which represents the relation $a' : a$. If we apply this formula to the Phœnix iron, and take the figures as before, 2,190 remains the value of u. Let us introduce into the formula the value of s, that is to say, 1,170, we have:

$$\frac{u-s}{u} = \frac{2190-1170}{2190} = \frac{7}{15}$$

M. Weyrauch observes that $\frac{7}{15}$ is very near to $\frac{1}{2}$, and he thus comes to:

$$a = 2170\,(1 + \tfrac{1}{2}\,\varphi).$$
$$b = 700\,(1 + \tfrac{1}{2}\,\varphi).$$

This is the same formula as Launhardt's, in appearance at least, for in the first is positive, and negative in the second. We have thus a table which allows us to use one or the other of those two formulas, and to take into account special cases, according as a strain is permanent, intermittent or alternative. Those formulas might be applied to cases of compression and extension, but a process, as ingenious as the preceding, has been applied for determining the influence of flexibility and determining the most suitable co-efficient. This process is based on a certain value of μ, which is obtained in this form: the product of the strain per square centimeter, multiplied by the square of the length of the object, and divided by the product of the co-efficient of elasticity and of the weight of inertia of the transversal section. This co-efficient, μ, may be introduced into the formulas, and when the object is exposed to flection by means of compression, the value of b can be replaced by the value of the strain per square centimeter, and multiply in a general way by $1 + \mu$, the value of μ being determined as we have said.

Weyrauch compares his results with a certain number of American formulas, among one of which is the following: American engineers, in the building of machines, admit that the resistances to which the pieces may be subjected vary very nearly in the proportions of the numbers 1, 2, 3, according as the strain is alternative, intermittent or continuous. Taken in the absolute sense then, the quantity $1 + \frac{1}{2}\,\varphi$ would bring us to the result that the quantities $1 - \frac{1}{2}\,\varphi$, 1 and $1 + \frac{1}{2}\,\varphi$ would be in the proportions of 1, 2, 3, which is equivalent to supposing that $\varphi = 1$.

According to American engineers, we would have to load objects submitted to a disconnected strain with 700 kilos per square centimeter; those having a continuos strain with one and a half times 700 kilos, or 1050 kilos, and materials which, on the other hand, are subjected to only alternative strain, could only bear a load of 700 less 350, or only 350 kilos per square centimeter.

The formulas are however of great interest, for instance, in the construction of a bridge, which is sometimes subjected to a permanent weight, and sometimes to an overweight. As we know immediately the value of φ, the solution of the problem is clear. A very curious application of the formula is given in the pamphlet. What dimension must be given to the pier of a bridge for which the dead weight is to the total weight in the proportion of 1 to 3, 5? The formula gives us immediately

$$b = 700\left\{1 + \frac{1}{2}\frac{1}{3,5}\right\} = 800 \text{ kilos.}$$

The above subject is to be discussed at the next meeting of the Paris engineers, when the position of the French and English schools will be thoroughly examined.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 313.)

LXVII.—WATERBURY.

Waterbury, Connecticut, is on the east bank of the Connecticut River, surrounded by hills.

Settled in 1667, and called Mattatuck until 1686, it was incorporated as a city in 1853.

In 1868 water-works were built by the city.

The works are managed by a board of five commissioners. Nelson J. Welton, C. E., was engineer of construction, and is the president of the board of water commissioners and superintendent, and Welton & Bonnett are the engineers to the board.

Water is taken from East Mountain Brook. The head of the stream is at some copious springs, 2,500 ft. from which a dam is built. Half a mile further down stream, and 175 ft. lower, is another dam, just below the junction of another brook.

The dams are of sand and gravel, with puddle walls in the centre and founded on rock.

The upper dam is 30 ft. high and 360 ft. long, and its slopes were lined with scrap tin to prevent damage from muskrats. The reservoir holds 100,000,000 gallons.

The lower dam is 25 ft. high and 265 ft. long. The reservoir holds 8,000,000 gallons.

A 12-in. pipe conducts water from the reservoir to the town. The lower reservoir is 225 ft. above the town.

In 1880 a line of 12-in. pipe was laid 3,500 ft. from the upper reservoir to a new storage reservoir on another stream.

An auxiliary reservoir was also built at Cooke street, for high service supply.

The first distribution pipes were of wrought iron and cement. All laid since 1877 have been of cast iron. On Dec. 31, 1880, there were in use 29 miles of pipe, 20 miles of which are less than 6 in. in diameter, 166 fire hydrants, 1,863 taps and 50 meters.

The consumption is not given. The population in 1880 was 20,269.

The total expenditures to Dec. 31, 1880, had been $327,277.82, and the receipts $204,079.45. The expenses for 1880 were $4,950.54, and the receipts $25,497.77. The bonded debt is $255,000.

LXVIII.—NEWBURGH.

Newburgh, New York, is on the west bank of the Hudson River, 61 miles above New York City. The city is built on the steep slope of a hill, rising to 300 ft. above the river. About half the city is less than 50 ft. above the river.

It was incorporated as a city in 1865. Water-works were built by the town in 1853.

The principal source of supply is Little Pond, since called Washington Lake, a natural pond with about one square mile of water-shed, and an area originally of 73 acres, increased by raising a dam across the outlet to 107.18 acres. In 1874 the right to use the water of Silver Creek, a stream about 2,000 ft. distant from the pond, was acquired, and a 24-in. cement pipe laid to connect them. The pond is 3⅓ miles from the river, and 276 ft. above it.

From the N. E. end of the Pond a 24-in. pipe, reduced after 3,128 ft. to 20-in., leads to Western avenue and William street in the city.

From the natural outlet of the pond another pipe, partly of cement, of 15-in. diameter, and partly of vitrified stoneware, of 18-in. diameter, leads 2,000 ft. to what is known as the Swallow Hole, a natural subterranean passage three-quarters of a mile long, ending at the Trout Hole reservoir, 200 ft. square and 232 ft. above the river, from which 15,200 ft. of 12-in. pipe conveys the water to a junction with the other main at Western avenue. The two pipes are also connected near the Trout Hole reservoir. For two years the supply in summer has been somewhat deficient, and water was pumped from the lake into the conduit. The distribution is by cast-iron pipe, of which 20.25 miles have been laid, with 181 fire hydrants and 1,789 taps.

The population of Newburgh in 1880 was 18,050. The consumption is not given.

The supply from the present sources is barely equal to the requirements.

The total cost of construction to March 7, 1881, had been $432,891.43, and that of maintenance $83,081.35, and the revenue $496,570.44.

For the year ending March 7, 1881, the receipts were $27,334.50, and the expenses $4,863,89. The bonded indebtedness is $284,500.

The works are managed by a board of five water commissioners. Charles B. Royce was superintendent until his death in 1873, and Edward C. Boynton since that time.

LXIX.—CORNING.

Corning, New York, is on the southwest side of the Chemung River. The ground is quite level near the river, but rises to an elevation of 100 ft. to the southwest.

* Copyright 1881.

Water-works were built by the town in 1870, and leased to Heermans & Lawrence for thirty years, the lessees to furnish water for fire protection.

Water is brought from Monkey Run Creek, a small stream a mile southwest of the town. A dam turns the water of the stream into a 12-in. cast-iron pipe, which conveys it to a reservoir holding one and a half million gallons, 250 ft. above the river.

The supply from the stream is less than the demand about half the time, and a Blake pump is used to force the water from some springs and ponds east of the town.

The distribution is by cast-iron pipe of 12-in. to 4-in. diameter, of which seven miles are laid, with 45 hydrants, and supplying 200 private consumers. The consumption is stated to be about 250,000 gallons per day, and the population about 6,000. The works cost $40,000. The revenue and expenses are not furnished. Harry C. Heermans is the superintendent.

LXX.—NORFOLK.

Norfolk, Virginia, in lat. 36° 51' N., long. 76° 19' W., is on the Elizabeth River, an arm of Chesapeake Bay, 32 miles from the ocean, on low, flat ground.

Founded in 1705 it was incorporated as a borough in 1736 and as a city in 1845.

Water-works were built by the city in 1872, after the plans of Robert K. Manning, C. E.

Water is taken from streams on low ground 4.6 miles from the centre of distribution in the city and pumped directly into the mains.

Two small dams at Moore's Bridges, 1,400 ft. apart, form reservoirs of 40,000,000 gallons capacity. In 1874 the dams, which were entirely of earth, were opened and puddle walls put in their centres. At the first dam a waste conduit of 2 in. pine plank coated with tar, 4 ft. by 1 ft. in section and 375 ft. long, was put in.

Two and a quarter-miles from Moore's Bridges is Lake Lawson, formerly called Cole's Pond, which has a capacity of 120 million gallons, with 85 acres area. The water of this pond is lifted 8 ft. by two Earle pumps of 1½ million gallons capacity, the suction pipe for which extends 70 ft. into the lake on a floating framework of oak and cypress timber. The water is pumped into a wooden conduit 12 × 18 in., which in 1878 showed signs of decay, and was partially replaced by 20-in. cast-iron pipe, and flows by gravity to Moore's Bridges, where it is pumped from a settling basin into a 12-in. cast-iron pipe leading to the city. The first pumps were a 2-million Holly 4-cylinder engine and 2 rotary pumps. In 1875 a Worthington engine of 1 million gallons capacity was erected.

In 1880 a Worthington condensing engine and a non-condensing engine, each with pumps of 2 million gallons capacity, were added, and an additional Worthington engine erected at Lake Lawson. On Aug. 18, 1879, a severe storm occurred, in which a part of the engine house at Lake Lawson was blown down and the dam settled considerably.

The distribution is by cast-iron pipe, of which there were on June 30, 1878, the date of the last report obtained, 21 miles in use, more than half of them of less than 6-in. diameter. There were 90 fire hydrants, 1,303 taps and 40 meters.

The daily consumption in 1880 was 707,984 gallons, and the population 21,966.

The cost of the works had been to Sept. 30, 1880, $531,618.75. The expenses for the year previous had been exclusive of interest $19,506.52, and the receipts $59,943.94. The bonded debt is $500,000.

The works are controlled by a board of two commissioners. Frank H. Hambleton, C. E., was resident engineer of construction. C. H. Rowland is the superintendent.

LXXI.—ERIE.

Erie, Pennsylvania, is on Lake Erie, about midway between Buffalo and Cleveland. The city stands on an elevated bluff. A French fort occupied the site in 1749. The town was laid out in 1795. It was incorporated as a borough in 1805 and as a city in 1851.

About 1840, wooden pipes were laid from a spring near the Buffalo road and Parade streets, supplying several small reservoirs for fire supply and a number of private consumers.

Water-works were built by the city in 1867-9, after the plans of Henry P. M. Birkinbine, C. E., taking water from Lake Erie through a 48-in. pipe laid in a crib extending 1,000 ft. into the lake and 13 ft. below the surface. The engine house is built on rock on the lake shore. Two Cornish Bull engines, with steam cylinders of 60-in. diameter and pump plungers of 21-in. diameter and 120-in. stroke, force the water into a stand-pipe 217 ft. high, inclosed in a masonry tower, whence a 20-in. cast-iron main leads to a reservoir built in excavation and embankment, the slopes puddled and lined with brick. It is in two divisions, their capacity being 30,000,000 gallons. The distribution is by cast-iron pipe, of which 35 miles were laid to Jan. 1, 1881.

In 1871 there were 1,320 taps and 92 hydrants. The reports give only the additions for each year and no summary of the total of taps, hydrants and pipes. One hundred and forty-six taps and 5 hydrants were added between May, 1879, and December, 1880.

In 1880 the consumption was two million gallons daily, and the population 27,730.

The cost of the works was $607,311. The expenditures in 1880 were $13,397.45, and the revenue $38,413.47.

The works are managed by a board of three commissioners. W. E. Hilton is the superintendent.

LXXII.—MARSHALLTOWN.

Marshalltown, Iowa, is on the bank of the Iowa River, a stream of considerable size, flowing through a rich alluvial soil.

Water-works were built by the town in 1877, after the plans of Thomas N. Boutelle, C. E.

Water is taken from the river and led by a 16-in. pipe to a well 20 by 30 ft. and 15 ft. deep near the river, in which is a filter of gravel and charcoal. From the well it is pumped by two Knowles pumps with 24-in. steam cylinders and 12-in. water plungers with 24-in. stroke, pumping directly into the mains. Distribution is by cast-iron pipe, of which there were in use on Jan. 1, 1881, 7.9 miles, of which 2 miles are of less than 6-in. diameter. There are 69 fire hydrants, and about 360 taps. The population in 1880 was about 6,000. The consumption is not given. The cost of the works has been:

For construction and repairs	$69,829.17
" interest	18,065.87
" maintenance	18,380.23
Total	$106,275.27

The total revenue from water rents has been $13,525.99.

The expenditures for 1880 were $24,629.05, and the revenue, inclusive of $8,387.22 from general water tax, $18,058.88.

The works are managed by a Water-Works Committee of three, of which John Turner has been chairman since 1876. The superintendent is not named in the reports.

LXXIII.—BINGHAMTON.

Binghamton, New York, is at the junction of the Chenango and the Susquehanna rivers.

The site is a nearly level plain.

Settled in 1787, it was incorporated as a city in 1867.

In 1868 water-works were built by the city, taking water from three wells near the bank of the river. These furnishing an insufficient supply, water was drawn from the river in 1876 and since, whenever necessary.

The yield of the wells is about one and a half million gallons daily.

Water is pumped directly into the distribution pipes.

The first machinery was a two-cylinder Holly engine, driving two rotary pumps. In 1876 a Holly compound four-cylinder engine and pumps was substituted for this.

Distribution was by wrought-iron and cement pipe, which caused trouble after 1875. Cast-iron pipes is being gradually substituted for it. On June 27, 1879, 100 ft. of pipe was destroyed by lightning. There were on Dec. 31, 1880, 25.8 miles of pipe in use, 13.25 of which were of 4-in. diameter. Seven miles of the pipe are of cast iron. There were 171 hydrants, about 2,360 taps and 5 meters. The consumption in 1880 was 1,700,000 gallons per day and the population 17,315.

The domestic pressure is 40 pounds, and the fire pressure 60 pounds.

The works were built and are managed by a board of five water commissioners. T. A. Sedgwick was the superintendent to 1875, and Darwin Felter has been the superintendent since that time.

The works cost about $200,000. The expenses for the year 1880 were $18,209.93, and the receipts, exclusive of an appropriation by the city of $8,185, were $28,984.36. A portion of the surplus income was devoted to payment of bonds and interest. The bonded debt is now $191,000.

LXXIV.—PARIS.

Paris, Illinois, is near the easterly boundary of the State and midway in the State north and south.

Water-works were built by the city in 1879, after the plans of J. G. Briggs, taking the supply from ground water. In the southern part of the town a basin was excavated through clay and quicksand, making a reservoir of 1½ acres area and holding four million gallons. A spring supplies it. A well 8 ft. in diameter, and 6 ft. deeper than the reservoir, was sunk to receive the suction pipe from the pumps. The water is pumped by two Blake pumps, each with two steam cylinders of 18-in. and two water cylinders of 10-in. diameter and 24-in. stroke, pumping directly into the mains. The distribution is by cast-iron pipe, of which 6.5 miles are laid, with 56 fire hydrants. Considerable trouble was experienced in pipe laying, as water was encountered at a depth of 36 to 40 in. in most of the trenches.

In the summer of 1881, the yield of the springs has been deficient, and resort has been had to driven wells. The works cost $39,705.76. The number of taps and the consumption are not furnished. The population is 3,500. J. C. Collum is the superintendent.

LXXV.—PAWTUCKET.

Pawtucket, Rhode Island, is situated on both sides of the Pawtucket River, 4 miles north of Providence. The water power was utilized in 1790, by Samuel Slater, the first American cotton manufacturer.

In 1877-9, water-works were built by the city, after the plans and under the superintendence of Walter H. Sears, C. E. They also supply Central Falls and East Providence. Water is taken from Abbott's Run. The water is impounded by a dam forming "Happy Hollow Pond." Its drainage area is 26 square miles, its capacity 72,000,000 gallons and it flows 23 acres.

From the gate house in the dam a 30-in. cast-iron pipe conducts the water 3,600 ft. to the engine house and pump well, from which the pumps take water. The water stands in the screen well at the same elevation as the flow line at Happy Hollow Pond, when the engines are not working; a difference of 0.85 ft. in level causes a flow through the conduit of 3 million gallons in 24 hours.

The pumping engine, designed and built by George Corliss, is a compound-condensing fly-wheel engine, of 3,000,000 gallons capacity in 24 hours.

The high-pressure cylinder is 15 in. in diameter, low pressure cylinder 30 in. in diameter. The stroke is 30-in. The diameter of the pump barrels is 30 in., and the diameter of plungers 10.52 in.

The water is lifted into the distributing reservoir, which is in excavation and embankment.

The depth of water is 23 ft., and the elevation of its flow line above tide level, 301 ft. The reservoir is built mostly on ledge rock, and good puddling material could not be obtained. The sides are generally cut in the ledge. Where embankment was required it was built of surface mold and earth in wetted layers.

The outer slope is 1½ to 1. The inner slope is 1½ to 1 for 27 ft. from the top, when it drops perpendicularly. At 8 ft. from the top of the bank, on the inner slope, a layer of concrete 1 ft. thick is laid, increased on the perpendicular to 2 ft., and is covered down to ledge rock.

At the foot of the bank the puddle is increased in thickness and width, and a dry stone wall about 15 ft. high with a batter of 3 ft. is built upon it and against the perpendicular wall of concrete. From the foot of this wall the bank slopes 3 to 1 for 15 ft. This slope and the bottom of the reservoir are covered with 6 in. of concrete. A 24-in. inlet pipe is carried up through the bottom of the reservoir near the centre, to floor line.

The masonry gate house containing the effluent pipe has 3 openings at different elevations. The supply main is of cast iron, 24 in. in diameter.

The distribution is by cast-iron pipe. On Feb. 1, 1881, there were 49.35 miles laid in Pawtucket, 7.75 miles in Central Falls, and 8 miles in East Providence, a total of 65.1 miles, of which 5.7 miles are of 2 in. diameter or less. The daily consumption in 1880 was 8 million gallons and the population 19,030. The number of taps in Pawtucket is 1,617, in Central Falls 366, and in East Providence 60, a total of 2,043.

On Feb. 1, 1881, there were 372 hydrants in Pawtucket, 57 in Central Falls and 42 in East Providence, a total of 471.

Meters have been in use since 1879. There are now 1,065, distributed as follows: Pawtucket, 790; Central Falls, 250; East Providence, 16.

The cost of the works has been $641,799.10.

The cost of maintenance for 1880-81 was $6,122.38, and the receipts from water for the same time $34,080.54.

The total water receipts from the beginning have been $57,476.22.

The works are managed by a water board of three members. Walter H. Sears, C.E., was chief engineer of Construction. Edwin Darling is the superintentendent.

(TO BE CONTINUED.)

NEW YORK AND BROOKLYN BRIDGE.

(*Continued from page* 314.)

PREPARATORY WORK FOR CABLE MAKING.

From a report of Mr. E. F. Farrington, Master Mechanic of the bridge, dated December, 1876, we take the following remarks in regard to this portion of the work:

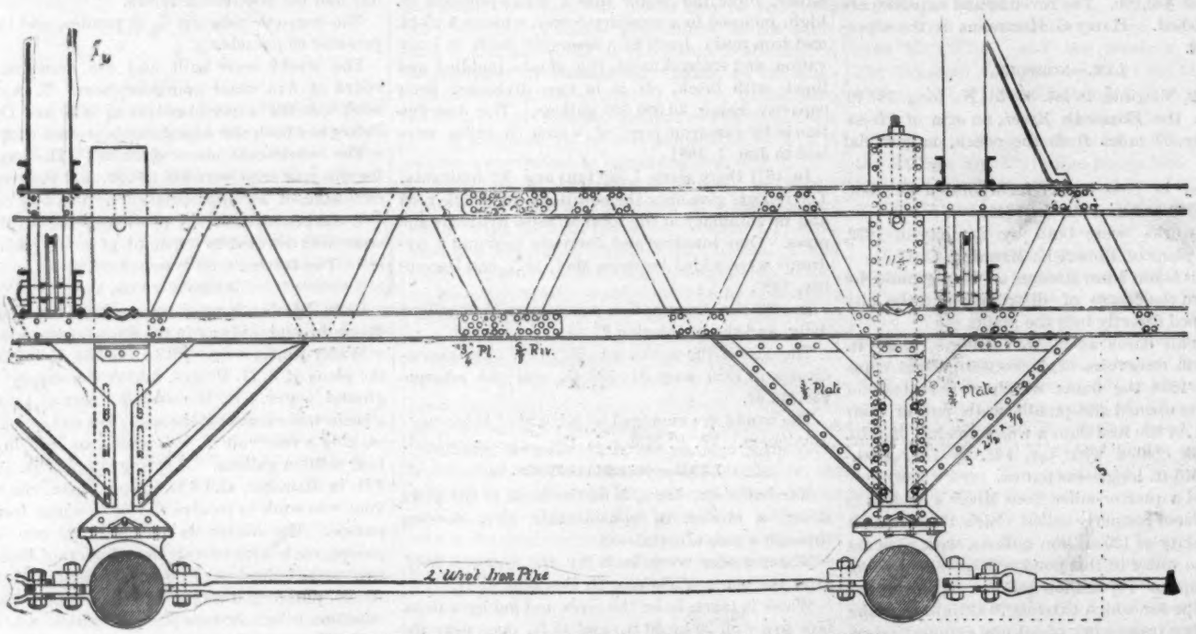
"The cable-making machinery is located on the Brooklyn anchorage, and it was made on the same general plan as that used in making the cables for the Covington and Cincinnati Suspension Bridge, with some changes to suit local requirements. It is in duplicate for making two pairs of cables at the same time, and each set is constructed so as to work independently of the other.

"The several parts of the running machinery are designated as follows: The driving-wheels, the guiding-wheels, the sliding, beveled gears, the counter-shafts, clutches, levers, pinions, segment gearing and the tightening pulleys.

"The driving-wheels are two in number, attached to upright wrought-iron shafts, which run in cast-iron boxes set in the masonry. These wheels are 11 ft. in diameter and 6 in. thick, having two grooves around the edge. The guiding-wheels are single grooved, 4 ft. in diameter and 3 in. thick. Three of these, with a driving-wheel, form one set, and they all run in the same horizontal plane, except the center one, which is inclined the thickness of the rope. They are so constructed that the working rope or 'traveler' runs on the end grain of the wood. The traveler is so arranged around the driving-wheel that the bearing surface is equal to one and one-third times the circumference of the wheel, and this friction has been found to more than equal the power of the driving-belt.

"A horizontal wrought-iron shaft, 3½ in. in diameter, runs on the Front street face of the anchorage masonry; and the motion is given to it by a 16-in. leather belt 98 ft. long, leading from the fly-wheel of a steam engine in the yard below. From pulleys on each end of this shaft, 8-in. belts lead to pulleys on two short, horizontal counter-shafts, on the top of the masonry. On each counter-shaft are two sliding, beveled gears, worked by a clutch and iron lever, so as to give a forward or reverse motion to another beveled gear, which is fastened on the lower end of an upright iron counter-shaft. On the upper end of this shaft is a pinion, which works in gearing, bolted in segments on the top surface of the wooden driving-wheel. Each set of machinery is fixed in a heavy timber frame, which is securely fastened to the masonry. The 8-in. bolts run loosely on the pulleys, and the machinery is put in motion or stopped by a tightening pulley, worked by a lever, without stopping the engine.

"On the New York anchorage each traveler runs around two 4-ft. wheels, like those in Brooklyn, placed in a sliding frame, which is so arranged that the slack in the rope, arising from its stretching, can be taken up at any time without cutting and splicing. All of these wheels are made of oak.



SECTION SHOWING ROADWAY RESTING ON CABLES.

"Under the head of machinery we may also include the drums for holding the wire, the reels and traveling sheaves. There are 32 drums placed in the wire shed, which was erected some time since on the Brooklyn anchorage. They are 8-ft. outside diameter, 16-in. face, with a depth of rim of 6 in. Their working capacity will be about 50,000 lineal ft. of No. 8 wire. * * *

"The 'traveling sheaves' which are to be used in running out the wire for the main cables, are 5-ft. outside diameter. They are made with six light wooden arms, radiating from a wooden hub, and a light wooden rim 2 in. thick, in the outer edge of which is a V-shaped groove about 1 in. deep. The groove is lined with galvanized sheet iron, which projects 4 inches beyond the wood, thus making the groove about 5 inches deep. The outer edges of this iron are stiffened by having a wire rolled into them, and by thin strips of iron which are riveted at intervals to the outside of the V, and bolted to the wooden rim. Thirty-six holes, 3×2¾ in., are cut in the sides of these rims opposite to each other, for the free passage of the wind.

"The wire ropes are 17 in number, made of galvanized steel wire. Taken in rotation, their names, sizes and uses are as follows: Four 'travelers,' ¾ in. in diameter, spliced into two endless ropes around the propelling machinery before described. They have been used for hauling over the other ropes, in part, and for hauling the buggies back and forth, but their final use will be to carry the traveling sheaves when the wire for the main cables is run out.

"The next in order is the 'carrier,' 1¾-in. diameter, for holding the weight of the heavier ropes, when they were hauled over the river. Next, 3 cradle ropes, 2¼-in. diameter, for support-

ing the cradles, which will be described further on. Two foot-bridge cables, on which a foot-walk for the use of the cable workmen will be laid. These ropes will also support one end of 5 of the 10 cradles. One 1¼-in. diameter auxiliary rope, which, with the carrier, will finally be used to assist in supporting the foot-bridge. Two 1¼-in. diameter 'storm cables,' which will extend from one tower to the other below the roadway, and be attached to the foot-bridge cables by small wire-rope suspenders in the form of inverted cables to prevent the foot-bridge from being lifted by the wind. Two ⅝-in. diameter ropes, for hand-rails for the foot-bridge, and 4 'pendulum ropes,' ¾-in. diameter. These will be used to support small iron rods, having flat leaden weights attached to their lower ends, which will separate the two parts of each strand of the main cable while they are being laid, and prevent their entanglement by the wind. The travelers, carrier, cradle cables, and the foot-bridge cables are in position.

"The difficult and dangerous problem, how to get the wire ropes across the river, and over the streets and buildings from one anchorage to the other, was safely and expeditiously solved, in the following manner:

"The two travelers were the first to be taken over. The reel containing the first ropes was placed on a wooden axle, in a frame on one of our stone scows, at the foot of Brooklyn tower. The end of the rope was then hoisted over the tower, and drawn down into the yard, where a manilla rope leading to a steam engine at the anchorage was attached to it, and it was carefully hauled to the anchorage and made temporarily fast there. Fenders and trestles were erected, and men were stationed on the roofs of the intervening buildings to protect them. The operation was entirely successful.

"The scow containing the reel with the remainder of the rope, was then towed over the river to the dock at the foot of New York tower, and the bight of the rope, as it unreeled, was allowed to sink to the bottom. The scow was made fast to the dock, and all the rope on the reel was coiled at the foot of the tower, after which the end was hoisted to the top of the tower, and drawn down and fastened to one of the grooved drums of the stone-hoisting engine.

"It was at first supposed that the ropes would have to be hoisted out of the water on a Sunday morning, when there were few vessels in the way; but by frequent observations I learned that we could get from 4 to 8 minutes clear water, on any day of the week, and it was resolved to make the attempt as soon as we were ready.

"Engineers Martin and McNulty took position in the roadway of the tower, to watch for an opening. Foreman Dempsey, with some workmen, was left on the top of the tower; while I clambered up on the hoisting frame to note the deflection, with William Brown, carpenter, to pass signals to the engineer of the hoisting engine, when to start and when to stop.

"A tedious wait of more than half an hour followed. At last I heard from Mr. Martin the welcome words, 'Go ahead!' and passed them to Brown, who signalled the engineer. In a few seconds the rope began to move; there was a ripple around it in the water; it began to draw away from the dock toward Brooklyn, and soon we could see the other part coming from Brooklyn towards us. Faster and faster the space of clear water between the two parts narrowed, and in four minutes from the time of starting, it swung clear of the surface of the water, with a sparkling *swish*, amid the cheers of spectators, on the wharves and ferry boats, and the shouts of our own workmen.

"Up went the rope, and when it reached the level of the roadway, the engineer was signalled to go slow, and the speed lessened. When it was within a few feet of its proper deflection, 80 ft., I passed the word to slow the engine, which was done, but not until the rope had reached a point somewhat above the intended deflection, though in time, however, to prevent any damage to the rope. This occurred Aug. 14. The second rope was taken over in the same manner, on the same day.

"These ropes were securely fastened on the top of the tower, and the two ends were then hauled over the streets and roofs to New York anchorage, much in the same manner as in Brooklyn. The ends were next spliced together, around the driving and guiding-wheels, thus forming one endless rope, capable of being worked to and fro, to draw loads and to carry burdens. It is arranged to run in wood-lined wheels on the towers, and although it has seen much hard service, it bears no perceptible marks of wear.

"The two parts of the other traveler were taken over by being lashed to the first one, and then carried over by steam. After being taken over, the ends were secured on the two anchorages, and the lashings were cut loose by men seated in "boatswain's chairs"—rude contrivances much used by riggers—which were arranged to slide on the first traveler. * * *

"The carrier was got over in the same manner as the first travelers—through the water. The tug, in towing the scow across, made a detour down stream, so that when an attempt was made to draw the rope out of the water, the side strain was so great as to pull it out of the 3-ft. wooden wheel, in which it was running on the tower. * * * The rope was replaced in the wheel, and a guiding sheave was put on it outside of the tower, and it was then hauled up without further difficulty.

"After being hauled out of the water, the end was taken from the grooved drum, and hoisted to the tower again, on the land side, and fastened to a snatch-block which ran on the traveler. A manilla rope, some 300 ft. long, was made fast to the end of the carrier, and the block was allowed to slide down on the traveler, toward the anchorage, carrying the end of the wire rope with it. It ran down 350 ft. by its own gravity, the bight remaining coiled on the dock. When it would go no further in this way, men pulled it along the anchorage by the manilla rope. There a tackle was attached, and it was strained up to its correct deflection, by steam, and fastened by a socket and stirrup. I found it lessened the danger and the labor to hang the end of the rope to the traveler, as above described.

"To get over the five other large ropes, I adopted the plan which I used so successfully at Niagara Falls, namely, by suspending the weight of the rope to be hauled on the carrier, and hauling by the traveler, or a manilla rope, worked by a steam engine. The first cradle cable was hauled by the traveler; but this plan did not work well, owing to the frequent slipping and breaking of the belt, which transmitted power to the machinery. This rope was landed in New York, and it cost much labor to get it into position for running over, besides our trouble with the traveler.

"It was, therefore, determined to land the remaining ropes at the foot of the Brooklyn tower, which would bring them at once into position; and to do the hauling by a manilla rope, worked on the grooved drum before mentioned. The operation was conducted as follows:

"The manilla rope was first drawn over the river by the traveler, and made fast temporarily on Brooklyn tower. It was suspended from the carrier by small clevises, which prevented the bight from dropping in the way of passing vessels, and at the same time allowed it to move freely. These clevises were put on 80 ft. apart. Another rope was drawn up from Brooklyn anchorage in the same manner, and one from New York anchorage.

"A stick of oak timber, 6×10 in. and 10 ft. long, was fastened by stirrups on the top of the carrier just outside of Brooklyn tower, on the water side. To this a large grooved cast-iron pulley was hung. A 14-in. leading block was also made fast to this stick, near the iron sheave, and through it a 4½-in. manilla rope led to an engine on the dock. By this rope the end of the wire rope was hoisted from the reel on the dock below, and run over the iron pulley. The hauling rope from New York was then made fast to the end of the wire rope, and the New York engine was started, and with the aid of the dock engine in Brooklyn, the wire rope was hauled 10 ft. toward New York, and then the first hanger was put on.

"These hangers were grooved iron sheaves, 8 in. in diameter, to which a pair of "sister hooks" were attached in such a way as to allow of their being opened and slipped over the carrier in the most expeditious manner. The cables were lashed below the hooks by 1½-in. hemp ropes. Thus the hauling-line pulled the cable along, while the hanger ran easily on the carrier, and held the weight of the cable lashed below. The hangers were put on about 60 ft. apart. The oak stick was used to prevent the carrier from being strained, at too sharp an angle, by the weight of the cable and hoisting-line. A buggy hanging on the traveler was used for two men to stand in to put on the hangers.

"In this way a cable was drawn to the New York anchorage; a line from that anchorage being attached as soon as the end of the cable reached the tower. It was necessary to use the line at Brooklyn tower to assist in lifting the weight of the cable, until 350 ft. had been run out, after which the New York line did all the work. I also had to "fleet" the New York line 400 ft., on the main span, to help the line from New York anchorage.

"When the end of a cable reached New York anchorage, a wrought-iron socket was put on, and it was attached to an anchor iron in the masonry by a stirrup. Meanwhile the end remaining on the reel was taken off and coiled on the dock, and then hoisted to the top of Brooklyn tower, and hauled to the anchorage by the line before mentioned, the weight being held by hangers on the carrier.

"The cable was next strained up until the hangers were relieved from its weight, when they were taken off by men who went down in buggies for that purpose. The buggies ran on the carrier, and were hauled back by the traveler. The cable was strained up still further, to the required point of deflection in the center of the main span; then it was cut off, and an attachment was made by a socket and stirrup, as in New York. On the towers the cables ran on two grooved oak wheels, 3 ft. in diameter and 6 in. thick. When a cable had been taken over and fastened, it was lifted out of these wheels by powerful screws, set in a strong frame, and lowered on to permanent oak blocking. This plan was pursued with two foot-bridge cables and two cradle cables.

(TO BE CONTINUED.)

CORRESPONDENCE.

PLAN FOR REMOVING REFUSE.

NEW YORK, Aug. 16, 1881.

EDITOR ENGINEERING NEWS:

I take this method of calling your attention to a plan for the removal of ashes and garbage from the *rear lots* of houses without offense to sight or smell. Also to do away with the necessity of placing barrels or boxes on the sidewalks.

The plan is to put up a tramway on posts as high as the top of the rear fence. On this a car of sufficient size to convey two boxes to the cart in the street is run, the two boxes being transferred from the car to the cart and making one load, ashes or garbage only, in each box.

The details by which the boxes are taken up from the rear yards and placed on the carts by derricks or otherwise will be simple and easily operated by one man.

The entrances to the rear of lots will be through the backs of the avenue lots, or if these are built up an entrance through a 6-foot arch-way is placed where most convenient.

The elevation of the tramway may be continued over the sidewalks on a portable track when collecting and transferring the boxes.

The whole structure may be of wood and inexpensive.

By this means New York would enjoy the advantages of those cities which have alley ways in the rear of houses, and also be freed from the inconvenience of delivering refuse in the fronts of houses.

My address is care of J. D. Crimmins, Esq., 1,037 Third avenue. JOHN AVERY, C. E.

KALAMAZOO WATER-WORKS.

KALAMAZOO, Aug. 10.

EDITOR ENGINEERING NEWS:

I have been requested by many prominent persons here to correct some of the errors concerning the Kalamazoo Water-Works found in your valuable paper of the 6th inst., and more especially have I been requested to send you a newspaper article appearing over my signature in the papers here on the 26th ult., criticising the report of the committee of six that was appointed by the village authorities to write a history of our water-works.

Your published statement was probably compiled from the garbled report of the committee of six referred to.

Had not this committee been appointed you would have received a full history of the matter from Mr. Chandler, engineer of the works, and myself. At Mr. C.'s request I wrote out a full history of the discovery and development of our present supply, which is, I think, by far the best of any in this country. A description of it, and the mode of obtaining it, would have been doubtless

perused with much interest by your readers, and of great value to many places in the country that have unsatisfactory water supply.

The errors in your statement (except of *omission*) are not of much importance, however. Your geographical and geological outline is wrong, though of slight importance. The Kalamazoo Valley is not one-half of one hundred miles wide. The drift deposit, whether glacial or otherwise, is probably in the same disproportion. The Holly Works of 1869 were supplied from Axtell Brook. The works are not now *and never were* under the control of the chief of the fire department.

There is probably not a water-works in this country whose history, properly presented, would have afforded a more valuable and interesting chapter for your general history than that of the Kalamazoo works. Very truly yours,

W. R. Coats.

[Mr. Croes will be glad to receive from Mr. Coats or Mr. Chandler a correct description of the works. Owing to the indisposition of many of the officers of water-works to write descriptions, it is necessary to depend in most instances on printed reports. Corrections of errors and additional information will always be gladly received and acknowledged. Ed. Eng. News.]

WIND PRESSURE UPON BRIDGES.

Chief Engineer's Office,
Chicago & Alton R. R.,
Chicago, Aug. 1, 1881.

Editor Engineering News:

To-day a copy of Vol. X of the Transactions of the American Society of Civil Engineers was handed to me. It contains a very interesting and instructive paper on the subject of "Wind Pressure upon Bridges" by that eminent engineer, Mr. C. Shaler Smith, M. A. S. C. E., with discussions upon the same subject by many of the most prominent members of the profession.

Mr. Gottlieb in his remarks says: "The Chicago and Alton Railroad has lately adopted the rule to increase the section of every member of the bridge on account of wind strains, even floor beams, track stringers, top chords and posts. I believe this unnecessary and rather detrimental to the structures, as it increases the dead weight, without adequate benefit to compensate for it."

In defense of our practice in this office I think that Mr. Gottlieb ought to have said that only such members of our bridges are increased in section to resist wind stresses as, after a careful study of the subject, we have found to be effected by such stresses. We think it highly essential in constructing our bridges to strive to so proportion the various members with their details as to make the weakest "part as strong as the rest." If a stress in any member, arising from whatsoever cause it may, brings a stress in another member, each member has the same claim for section to resist that stress as the other has. Therefore, if stresses due to wind pressure can be traced into "floor beams, track stringers, top chords and posts" surely these members ought to have section introduced to meet the additional duty required of them.

Mr. Gottlieb in his discussion further says that he thinks "it advisable that the sections of bottom chords of spans over 200 ft. should be increased to resist the horizontal strains from wind strains." If this be true he will, I think, admit that he ought to carry those strains into the details of the bottom chords and, therefore, that the sections of the chord pins ought to be increased to resist the additional stress in the chord bars bearing upon them, otherwise there is a weak detail in a most essential part of the bridge, as is shown by the old pins of the State Street swing bridge in this city and in the pins of the Prairie Creek double-track, through bridge, near Wilmington, Ill., lately taken down by this company. The latter being upon the open prairie was exposed to severe wind storms, and while the rolling load for which the bridge was calculated was much less than that actually brought upon it in later years, still, I believe that high winds may have very materially effected its permanency. This span, I would say, was only 102 ft. 6 in. from center to center of end pins.

At present it is the practice in this office to allow for a wind pressure of 32 lbs. per square foot, considered as acting at right angles to the center line of the track, 50 per cent. being added in through spans and 100 per cent. in deck spans to the calculated surface directly exposed by one truss; the rolling load presenting 8 square feet per lineal foot, and the center of gravity of the moving surface being 8 ft. above the top of stringer. This pressure (256 lbs.) per lineal foot of train is somewhat smaller than is recommended in the volume before me, but we allow no higher strains per square inch in tension or compression in members either wholly or partially affected by wind pressure than is permitted for stresses due to constant and rolling loads. Our maximum tension is 10,000 lbs., and maximum compression 7,500 lbs. We do not consider these too small for spans up to 200 ft.

The use of the same permissible stresses per square inch of section for stresses from all sources greatly facilitates the deduction of the required areas, since stresses from any source may thus be conveniently combined with those from any other. It is not, as is done by some, the wind pressure of 256 lbs. per lineal foot of rolling load that we treat as rolling load in finding the stresses in the leeward truss due to wind pressure, but the *excess load* borne by the leeward truss due to the effect of the wind in throwing more than the normal weight per lineal foot onto the leeward wheels. This *excess load* may, or may not exceed, equal or be less than 256 lbs. per lineal foot, depending on the distances of the trusses apart and the distance above the top of the floor beam of the center of

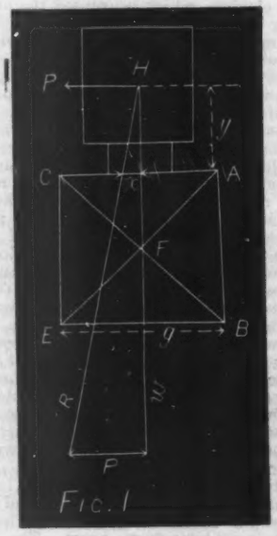


Fig. 1

gravity of the surface exposed to wind by the rolling load, but not, as might as first appear, upon the rolling load. The general formula we use is deduced as follows:

Let H be the axis of the rolling lead;
F " " axis of a deck span;
w " " rolling load per lineal foot;
P " " wind pressure per lineal foot on the train;
g " " distance between trusses, center to center;
y " " distance above top of floor beam of center of gravity of exposed surface of rolling load;
R " " resultant of w and P;
x " " the distance from the point of intersection of the action line of w with the plane of the tops of the floor beams, to the point of intersection of the action line of R with the same plane.

$$x = \frac{P}{w} y; \quad \frac{x w}{g} = \frac{P y}{g} = \text{excess load}$$

per lineal foot borne by leeward truss EC.

The formula we use for the overturning action of the wind is deduced as follows:

Let F be the axis of the span:
w' " " weight of bridge per lineal foot;
P' " " wind pressure per lineal foot on the structure;
g " " distance of trusses apart center to center;

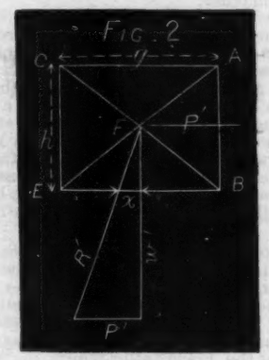


Fig. 2

h " " height of trusses center to center of chords;
R' " " resultant of P' and w';
x' " " distance from the point of intersection of the action line of w' with the plane of the center line of the bottom chords, to the point of intersection of the action line of R' with the same plane.

$$x' = \frac{P' h}{2 w'}; \quad \frac{x' w'}{g} = \frac{P' h}{2 g} =$$

the excess weight per lineal foot over one-half of w' borne by leeward truss.

Since this formula shows that the *excess load* is inversely as the distance apart of the trusses center to center, when the *excess load* borne by the stringer is to be found, we must substitute for g in the above formula the distance of the stringers apart center to center. It is quite evident that if any excess load ever reaches the leeward truss, it must do so through the "floor beams and track stringers," and that when once transferred to the members of that truss it must act upon the "top chord and posts" as well as the tie bars, in exactly the same manner as one-half the total rolling load does. An error might at this point be introduced by some by adding the *excess load* directly to one-half the total rolling load and computing the stresses in the leeward truss arising from both sources at one operation. This would not always be correct, since the effect of wind pressure on the bridge tending to overturn it, and its horizontal effect on the lateral systems, of which the chords form a part, may act in unison with the stresses due to the excess load or opposed to them, depending on whether a through or deck span is under consideration, and in the latter case whether the span rests upon its top or its bottom chords.

Here again we find that the weight of the bridge does not enter into the value of the result. A slight error here enters, for we presuppose that all the connections are perfectly rigid to resist an overturning force; but there are several similar suppositions, equally erroneous, in the present

practice of calculating stresses in bridge members, *e. g.*, that trusses at the panel points are perfectly flexible, and that the action lines of all forces intersect there.

The horizontal action of the wind acting on both bridge and train is treated in the usual manner and properly combined with the other stresses, either positively or negatively, as is required by the nature of the problem under consideration.

We do not think it advisable to rely on the "factor of safety" to overcome strains of any description, and do not introduce it for the purpose of knowingly permitting encroachment upon it. Our Chief Engineer, Mr. K. F. Booth, M. W. S. C. E., would strongly object to the use of rolling loads any in excess of what our bridges are calculated to carry, and has, therefore, fixed upon those which cannot with safety be exceeded while our present weight of rail (70 lbs.) is in use.

For spans that have come under our observation the percentages given by Mr. Gottlieb of the increase in the section of bottom chords due to wind pressure are about right, when the above method is used, which, however, gives larger percentages than the simple horizontal action of the wind, which, I take it, was alone used by him in obtaining his results. We have found the following for the percentages mentioned:

	Per cent.
160 ft. through span	34
111 " " "	28
105 " " "	25
78 " " "	24
103 " deck span, swung from top chords	6
75 " " " " " " "	2
51 " " " " " " "	0
62 " deck plate girder	7

Our specifications require that there shall be 16 feet in the clear between trusses in through spans and 14 feet over all in deck spans.

I find after many careful observations that in bridges proportioned in strict accordance with our specifications, if one one-half the required camber ($\frac{1}{1200}$ of span) be taken out in the iron floor system, the rolling load will take out the remainder, thus necessitating the notching of the ties over stringers all to the same depth, a marked advantage over the old custom of taking out camber in the wooden floor system, especially since in the future, when it becomes necessary to replace a part of the old ties with new ones, a smooth floor can be as easily obtained as if all the ties were new.

If desired by any of the readers of this article, and the editor can spare space in the valuable columns of his paper, I will be pleased to publish the stress sheet of our Petersburg Sangamon bridge, 156 feet through Whipple spans, and also of a deck span swung from the top chord, showing the method we employ in combining the stresses in the different cases. The sheets will also show the percentages of increase in area due to wind pressure of each member, over and above the sections required by the constant and rolling loads, together with several other interesting points.

I would be pleased to hear this method of considering stresses due to wind pressure discussed, and will endeavor to reply to any questions that may be asked with regard to our practice in treating them. Very truly yours,

E. J. WARD, Asst. Engr. C. & A. R. R.

DRAINAGE OF THE TWENTY-THIRD AND TWENTY-FOURTH WARDS, THIS CITY.

(*Continued from page 227.*)

Legislation should be procured at once to preserve this portion from pollution. Of course this whole area could not be restricted as to use, for the sake of merely maintaining the purity of the brook, and such restriction would be quite unnecessary. The simple protection required should be for the actual brook, that nothing offensive, such as the refuse from any manufacturing or farm establishment, or sewage from any source, should be allowed to flow directly into it. Even road washings should be excluded as much as possible.

The plans already adopted by this Department will, when carried out, preserve unpolluted and harmless that portion of the stream within the city limits. Many years must necessarily elapse before these plans can be fully carried out, but a beginning should be made at an early date by arranging the channel of the stream in its ultimate permanent position, and with a uniform descent, say of 10.5 feet per mile, from the Yonkers line to Van Cortlandt Lake, and from there to Spuyten Duyvil Creek, of 6 feet per mile. Where necessary to maintain grade and direction the bottom should be paved and the sides walled, care being taken to allow a section large enough to accommodate the greatest possible floods.

The difference between the amount of ordinary flow of this stream and that occurring during seasons of flood is excessive, so that, if a channel were constructed of sufficient capacity to accommodate floods, the stream ordinarily would occupy but a small part of it, and would tend to become very sluggish unless the section were made similar to a parabola—Fig. 3.

The objection to such section being that too great depth is required, the banks of the stream would, like those of many canals in Holland, be elevated above the surrounding country. A better section would be one similar to that shown in Fig. 4, having a very broad paved and comparatively shallow flood channel, *a a*, with a small channel *b*, for ordinary flow below the level of the larger one.

After the completion of such improved channel, the old tortuous one, as well as any adjacent salt meadow, should be filled, particular care being taken that this operation progress from north to south, to the end that the tide may flow freely through the old channel as far as the same may remain unfilled. By filling in the salt meadow and old channel at any point, regardless of system, such filling would serve as dams, and the most undesirable sanitary condition would ensue—namely, that of turning the old channel into stagnant pond-holes and the salt meadow into a fresh-water swamp.

The mixture of salt and fresh water is not only dangerous to health, but, when stagnant, is excessively offensive.

The new and old channels would always be so close together that I do not apprehend it will be necessary to construct drains in the old channel.

The stream crossing Mosholu avenue, about parallel with Broadway and some 400 or 500 feet easterly therefrom, is the most important feeder of Tibbet's Brook.

It is, taken as a whole, somewhat sluggish, owing to its slight fall, and requires attention. I can make no definite recommendation in regard to it for lack of full enough data. The fall should be equalized as much as possible by cutting in some places through the rock, and in others by walling up the sides. I do not think that any improvement west of Broadway requires to be made by the public; the few small swamps and muddy places should be improved by those owning the land. South of Mosholu avenue a special survey should be made with a view to public improvement.

The large swamp east of Jerome and north of Grand avenues, deserves early and particular attention. It covers some 30 or 40 acres, and is probably the most extensive fresh-water swamp in the annexed district. In its present condition it cannot fail to be highly malarious. As far as I am able to ascertain it can be readily drained. The construction of less than 1,000 feet of main drain will lower the plane of saturation from 6 to 10 feet. I should therefore recommend that a good-sized main covered drain should be built through Knox street, and that branch drains, also covered, should be constructed midway between Jerome and Kepler avenues, Kepler and La Grange avenues, La Grange and Mitchell avenues and Mitchell and Napier avenues.

The owners of the land could then complete its reclamation by a system of tile spur drains extending from the branch drains.—Fig. 5.

The little swamp on Jerome avenue, just south of the city line, can be readily drained by a system similar to that last described, only on a much smaller scale.

A swampy locality exists just east of the aqueduct and south of Mosholu avenue which should be drained—probably by private enterprise.

That portion of the small stream lying north of the Gun Hill road and east of the aqueduct, requires some private improvement.

The large open ditch, just east of the Dickenson mansion, would be much improved by being converted into a covered drain.

I would recommend, as a very desirable public improvement, the drainage of the lands between the northern half of Jerome Park and Boston avenue; the few exisiting open ditches are inadequate for the purpose.

The sanitary improvement most imperatively demanded within the limits of the water shed under consideration, and which should be attended to before any other recommended above, is the filling in of the salt meadow between Albany avenue and Broadway, near the Giles property.

Several small streams descend from the high ground and spread over this marsh; in addition it is made the receptacle of all kinds of refuse, and the sewage from the numerous cottages bordering upon it.

I have direct medical testimony that, as might be expected, the locality is decidedly and constantly malarious. The small streams referred to had best be combined east of Albany avenue, and carried as one, directly to the adjacent small tidal estuary and not suffered to spread over the marsh.

The sewerage of this locality should receive attention at an early day.

Finally, I would recommend the thorough deepening of the upper end of Van Cortlandt Lake by dredging, using the excavated material to raise the adjacent low places.

4. THE HARLEM RIVER WATER SHED.

This consists of that portion of the eastern bank of the Harlem River extending south from Kingsbridge to Jerome avenue, being a comparatively narrow strip, about 4 miles in length, with an average width of 1,600 ft., and containing 992 acres.

The ground rises rapidly from tide level at the Harlem River to a maximum elevation of over 180 and a minimum one of about 120 ft. above the same. The average of the minimum slope is over 3.5 ft. per 100.

Few recommendations are in place for this district, as there can be but little need of artificial improvement in a district with topography as described.

The salt meadow between the Kingsbridge road and the S. D. & P. M. R. R. should be filled.

There is also a small swamp, or pond-hole, just north of the Fordham Landing road and east of the railroads; this also requires doing away with by filling. Several smaller similar places southerly, along the railroad, should receive the same treatment. In this work care should be taken to give all drainage courses, as well as brooks, free and direct access to the river through the railroad embankments.

The covered drain through Jerome Park, from the race track south, needs repairing.

The area between Kingsbridge road, Jerome avenue, Croton avenue and the aqueduct has many wet and marshy patches.

The present dilapidated system of open drains should be replaced by deeper covered ones, with increased descent.

A small wet area near Bremer avenue and Union street can be readily drained whenever a sewer is constructed in Wolf street.

Whether it will be safe to depend upon the Harlem River as a permanent receptacle for sewage remains to be seen. I believe that it may be safely so used, for many years at least. The improvement about to be undertaken by the general government will greatly help in this respect by increasing its volume. Should it be proved, in the course of time, that such use of the river was becoming hurtful, the proper course will then be to construct intersecting sewers along both banks of the river, discharging them into the Hudson River on the west, and Long Island sound on the east. Such sewers would be works of no small magnitude, probably involving the building of pumping stations.

The arrangement of streets on both sides of the river should be carefully planned with a view to this contingency.

5. CROMWELL'S CREEK WATER SHED.

This district, which lies along Jerome avenue on either side, contains nearly 1,000 acres, extending from near Jerome Park to the Harlem River. It contains some salt meadow and considerable fresh-water swamp. The sides of the valley are so steep—average minimum about 1 in 20—that they are generally dry, or can be readily made so by a little private enterprise.

All the drainage from the eastern and western sides of this valley flows very directly into Cromwell's Creek. The tide rises and falls in the creek from its mouth, for 4,000 feet or more, northerly; above the stream is a fresh-water one, with an average fall of about 1 foot in 350 feet.

Jerome avenue, for nearly a mile, is located over or alongside of a narrow swamp. I should recommend that, from about Burnside street to Tremont avenue, the present stream be replaced by a covered drain, built through the middle of the block, between Jerome avenue and Punett street; thence carried across to the western side of Jerome avenue, and then southerly, parallel with Jerome avenue and 100 feet therefrom, to the vicinity of Orchard street; thence crossing Jerome avenue back to the eastern side, and continued southerly some 1,500 feet through the middle of the block, between Townsend and Jerome avenues; thence across Jerome avenue to Goble's ice pond. I am not prepared to say that this pond in itself is dangerous to health, yet its maintenance seriously interferes with the drainage of the valley, as the elevation of its surface must control the depth of any drain emptying into it; certainly in this respect its abolition, which is only a question of time, is to be strongly recommended. Were its surface lowered only a few feet it would be a great help to the drainage of the valley. While it stands at its present elevation it would be useless to construct the above specified drains much south of Orchard street.

Between Goble's ice pond and Jerome avenue there is but little swamp. I do not think that any other improvement is yet required here other than to deepen and straighten the channel at points.

The sooner the flats on either side of the creek, between Jerome avenue and 161st street, are filled in the better.

6.—ICE POND BROOK WATER SHED.

This small district, of some 530 acres, is one greatly neglected in respect to drainage and stands pre-eminently in need of it. It extends from the Zborowski estate to the Harlem River, about three miles north of 158th street. There are few dwellings contaguous to the Ice Pond Brook, although many fine houses are located within a few hundred feet of it on the high ground on either side, the occupants of which must to a great extent be affected by this malarious valley. South of 158th street the Harlem Railroad crosses the valley diagonally for about 6,000 feet in length, intersecting the Ice Pond Brook near 153d street. To the east of the Harlem Railroad lies the thickly settled district known as South Melrose. Here, as might be expected, the sanitary condition is extreamly bad, being thickly settled, with no sewers, the Croton water-system constantly being extended, the streets unpaved and nearly level, while the only outlet for the drainage is the sluggish polluted little stream which flows into the Mott Haven canal at about 144th street; there, meeting comparatively still water, its filth is mostly precipitated and is gradually filling up the basin.

I would recommend for this district:

First—That Railroad avenue be opened at once, and the outlet sewer for the district built in it. This is the key to the complete drainage of the district, and until carried out, it will be absolutely impossible to improve its sanitary condition, or even to drain the former site of the ice pond,

Second—That immediately following the opening of Railroad avenue, Sherman or Grant avenue be opened, and the main sewer extended up from Railroad avenue to about One Hundred and Sixty-fourth street.

Third—That north of One Hundred and Sixty-fourth street a system of covered drains should be substituted for the present brook, care being taken to see that branch drains are extended to all natural basins which are now wet.

In addition to its natural drainage the Ice Pond Brook water shed will receive the sewage from a small district of about 89 acres which now forms a distinct water shed about the lower end of Alexander and Willis avenues. Its drainage is naturally very good and requires no special consideration in this report.

7.—MILL BROOK WATER SHED.

This comprises some 2,534 acres, making it second in size only to that of the Bronx River.

At present it is the most important one under consideration, as within its limits is found the greatest portion of the population of the annexed district. It includes most of the built-up portions of the districts formerly known as Melrose, Morrisania, Tremont and Fordham. It is about six miles in length. South of Fordham station its average width is some 3,000 feet, while to the north it widens out considerably.

With a few exceptions, it will be unnecessary to consider that portion of this water shed lying within the Twenty-third ward.

The completion of Brook avenue sewer to One Hundred and Sixty-fifth street fully prepares for the drainage south of that point, while north of it Webster avenue is now being opened to One Hundred and Eighty-fourth street. The extension of the main sewer can follow such opening at once, and the flow of Mill Brook be turned into it.

As the level of this main sewer will be much below the present bottom of Mill Brook, there will be no difficulty in keeping the old channel dry. Where its course deviates much from the line of the sewer, covered drains should be constructed following its line, and should be carried into the sewer wherever possible. I would especially call attention to the urgent necessity of building a drain in the old channel of Mill Brook between Westchester avenue and 140th street. The present open channel is a terrible nuisance, receiving sewage and filth constantly, and in times of storm overflowing and then slowly subsiding and stagnating afterward.

I should recommend that, immediately upon the confirmation of the proceedings for opening Webster avenue to 184th street, a new proceeding to be initiated by this Department for continuing the opening of this avenue as far north as Middlebrook street, so that there may be no obstacle to the continuation northward to Mill Brook sewer when it reaches 184th street.

Middlebrook street, in turn, should be opened, and a main sewer—the continuation of that in Webster avenue—be constructed as far as Potter place. Beyond this point it cannot now be well determined whether it would be better to at once continue a sewer in Potter place to Jerome avenue, to construct a permanent drain in or near Potter place, or to temporarily improve the present channel of the stream, until such time as the sewer in Potter place should be constructed. The main branch of Mill Brook along Middlebrook parkway should be generally improved by egalizing its descent and converting it into a covered drain with branches to the various wet places in the vicinity of the intersection of the Gunhill road and Jerome avenue.

Quite a large area, just west of the upper end of Jerome Park, requires a public system of drainage. At present it is imperfectly drained to the eastward across Jerome Park. I think a thorough survey will demonstrate that for the system proposed it will be better to drain everything west of the aqueduct into Tibbet's Brook.

Either a public or private drain should be built from the pond-holes near Anthony avenue and Travers street, about parallel with Jerome avenue, north to Potter place.

The drainage between Perry, Hull and Middlebrook streets, and the Southern boulevard, requires attention on the part of the owners of the property.

I should recommend that the little brook between the Williamsbridge road and Briggs avenue, which empties into Mill Brook near John street, should be replaced by a covered drain. It is already polluted by sewage.

There are many small detached areas in Fordham that are in need of drainage, but which are so scattered that it would be simply extravagant to reach them by any public system of drains. Doubtless much can be done in this respect by the owners themselves. In many cases, however, it will be cheaper to push forward the construction of sewers for the purpose of accommodating the drainage somewhat in advance of the actual need of them, simply as sewers, rather than build at once a system of drains, and in a few years afterward, an independent system of sewers.

The depressions just west of Fordham avenue, near One Hundred and Eighty-second and Samuel streets, where water very frequently stands, will be relieved when a sewer in Fordham avenue is built, which can be done simultaneously with the Mill Brook sewer construction.

A covered drain should be constructed to replace the present small stream situated near Fordham avenue south of the Quarry road. A branch of this drain should tap the old ball ground at the corner of Locust avenue and Broad street.

The little stream just south of Fairmount avenue should be replaced by a covered drain as far west as to connect with existing ones.

Possibly it would be necessary to place a drain midway between Fordham and Madison avenues, say from Tremont avenue to One Hundred and Seventy-fifth street, and from One Hundred and Seventy-fourth to One Hundred and Seventy-second streets, but I am led to think that the better plan, certaialy the more economical one, would be the construction of the sewerage system in this thickly-settled locality. Its completion will, in most cases, render unnecessary the construction of special drains. This last remark will also apply to the wet swale on the line of the extension of Fulton avenue.

A large swamp, some twenty acres, more or less, situated on the Stebbins and Zboroski estates, requires reclamation by a carefully planned system of covered drains, with a main outlet passing southerly between Morris and Sherman avenues, and through Fleetwood Park.

Branch drains will also be required for Fleetwood Park and vicinity.

Until the permanent sewers are constructed, a temporary system of deep open drains will probably suffice for the low ground west of the New York & Harlem Railroad, and just north of Melrose station. As stated before, a permanent covered drain should occupy the former channel of Mill Brook, from about Westchester avenue to One Hundred and Fortieth street,* and the adjacent sunken lots somewhat raised.

The old channel of this stream and the salt meadow lying on both sides should be filled in, between One Hundred and Thirty-eight street and the Southern boulevard.

Before finishing with this district I would call attention to the urgent necessity of at once opening the following streets, namely:

Grove street, between Third avenue and Brook avenue.

John street, between St. Ann's and Brook avenues.

One Hundred and Sixty-ninth and One Hundred and Seventieth streets, between Railroad and Webster avenues, and One Hundred and Eighty-third street, from Fordham avenue to Webster avenue.

All of these are most necessary, as through them will have to pass the outlet sewers of very important sub-districts. All, with the exception of the last named, are necessary to secure the proper sewerage of extensive breweries and thickly built-up localities in which the Croton water system has been quite generally introduced. A sewer in One Hundred and Eighty-third street is greatly needed to sewer and drain the Home for Incurables and the low ground along Fordham avenue in that vicinity.

8.—BUNGAY CREEK WATER SHED.

This comprises about 408 acres, and includes within its limits most of the property subdivisions known as Eltona, Woodstock and East Morrisania, which are all pretty well built over. The Croton water system is already in several of the streets. This district stands exceedingly in want of drainage and sewerage. Comprehensive plans have been prepared by this Department to meet this want, but the work has never been given out on account of a decision of the Court of Appeals—made just after the plans were completed—which rendered it impossible to levy an assessment for drains built on private property without the consent of or compensation to the owners thereof. Under Chapter 360 of the Laws of 1880 the Board of Health has ordered proceedings begun to acquire the necessary right of way for a complete system of drains. Nevertheless, as sewerage is as much needed as drainage, and to avoid the extravagance of a double system of sewers and drains, I should recommend that the Department institute at once proceedings for acquiring title to Bungay street, Prospect avenue from the Southern boulevard to Westchester avenue, as well as Beach and Wales avenues between 152d street and Westchester avenue. The opening of these streets would enable the main sewers of the district to be built, and would furnish accessible outlets into which the existing little streams, and adjacent wet places, could be readily drained by short lines of drains, which in many cases should be built by the property owners. The little streams alluded to above are already dangerously contaminated in places.

I do not think that the salt meadow about the mouth of Bungay Creek needs especial improvement at present. In time it will have to be filled over; then care should be taken to fill systematically outward from the high ground toward the water, so as not to leave portions of the salt meadow cut off from the entrance of the tide while allowing the fresh-water drainage from the adjacent high ground to flow on it.

In the future a question may arise as to the advisability of emptying the trunk sewer of this district at the foot of Bungay street directly into the sound, which at this point forms a bay, or to build an intercepting sewer along the shore and carry all sewage as far east as Barretto's or Hunt's point before discharging it. I am not now prepared to give an opinion on this question. Continued and very careful examination of the littoral currents must be made before it can be determined. For-

* Since ordered by the Board of Health, under authority of Chapter 360, Laws of 1880.

tunately the adopted plan of streets is here adapted to such a contingency.

9.—PORT MORRIS WATER SHED.

This consists of 260 acres, situated south of the Port Morris branch of the Harlem Railroad, and east of Cypress avenue. Its drainage flows directly easterly and southerly, from the high ground to the salt meadow, and thence to Long Island Sound. About half the district consists of salt meadow.

Very little can be done at present to improve its drainage; in fact, I can see no necessity for the construction of any drains in this district, as the sewers which must inevitably be built will answer every purpose.

A careful supervision should be maintained, when street and railroad embankments are made, that portions of the salt meadow are not inclosed and so converted into fresh-water marsh. Where the grading of streets and railroads leaves sunken lots, they should in turn be filled in three feet or more, with clean dry earth.

10.—LEGGET'S CREEK WATER SHED.

It contains about 865 acres, and extends from East Tremont to Long Island Sound, lying just east of the old (eastern) town line of Morrisania. It is about 2.6 miles in length by ½ a mile in average width. The general surface of the ground is comparatively smooth, although ledges of rock crop out in a few places. Its elevation, except for a small area at the northern end, is less than 100 ft. above tide water. Transversely, the slope of the ground is ample to secure rapid and efficient drainage. The longitudinal slope of the main drainage stream is less than one foot in three hundred—ample for a large stream, or for a smooth artificial channel, but not for a stream of the size due to a water shed of no greater area than the one under consideration.

Between the Harlem River and Port Chester R.R. and Long Island Sound there is quite an extent, about 50 acres perhaps, of salt meadow.

This district, in proportion to its size, requires much artificial aid for its drainage.

There is no apparent reason why it cannot be properly drained, but it cannot be done without considerable expenditure.

As yet I think it would be premature to construcs main lines of sewers in this district. The best treatment, for ten years or more to come, will be to improve and maintain the natural water courses.

I should recommend that the main drainage brook be improved generally; by removing all dams; deepening and straightening its channel; and giving a uniform descent to the bottom as far as possible.

In many places, particularly at the upper end, this improved channel should be walled up and covered over. All wet places, such as exist along Clinton and Prospect avenues, should then be tapped by smaller covered drains connecting with the main.

In turn, property holders should be compelled to complete the system, within the limits of their own property, by tile drains.

The small stream originating near Minford place requires the same treatment at present as that suggested for the main stream.

11.—THE BRONX RIVER WATER SHED.

This water shed, the largest in the annexed district, contains some 2,700 acres, 300 of which lie in Yonkers, north of the city line, yet drain into the Twenty-fourth ward.

It contains the village of West Farms; the settlements of Fairmount, Belmont and William's bridge; and Woodlawn Cemetery.

It lies altogether along the western bank of the Bronx River, from Long Island Sound nearly to Mt. Vernon, a distance of about seven miles. Its width varies from about a mile to less than 700 feet.

Towards its mouth there is a large extent of salt meadow and of flat exposed at low tide, approximately 400 to 500 acres.

In Woodlawn Cemetery, and to the west of West Farms, occur quite extensive fresh-water swamps; among the latter is that known as the Walker swamp.

The elevation of the ground at the Western boundary of the water shed is always sufficiently elevated—280 feet being attained at the northern extremity—to insure thorough and quick drainage, were the slope to the Bronx uniform. Unfortunately this is not the case, the slope being much interrupted and broken up by out-cropping ledges, forming extensive pockets and consequently swamps.

An interesting beginning has been made toward draining this region by tapping one of these pockets. It is, in fact, the only attempt yet made toward public drainage in the annexed district. A large swamp of some 40 or 50 acres existed within the area included between the Southern boulevard, Kingsbridge road, Hoffman street and Pelham avenue. Investigation disclosed the fact that the little brook forming the only outlet for this swamp, was dammed by a ledge of rock, situated some 1,000 feet beyond the apparent edge of the swamp, and rising to an elevation only about a foot below that of the surface of the swamp. A cut of about 9 feet was made through this ledge, requiring the removal of only some 108 cubic yards of rock, and a covered drain built in the cut. This operation alone would in the course of a long number of years have probably sufficed to lower the plane of soil saturation sufficiently to have thoroughly drained the swamp, but in order to hasten the reclamation of the land at once, the drain was continued westerly about 1,500 feet, then dividing into two branches consisting of partly covered and partly open drains. The southern branch is about 860 feet in length, and the northern one 1,650 feet. The event has proved that, notwithstanding the increased cost of the covered drain having been about 3½ times that of the open one, it would have been best to have made it entirely covered in order to preserve it from being interfered with and damaged.

I think that, as a public work, the drainage should have stopped at this stage, and the completion of the details of the system left to the land owners. However, a contrary course was taken and a ramification of small blind drains extended to all pond-holes and wet places in the vicinity. It is very questionable whether small blind drains are ever of much permanent service, even when constructed most carefully and by days' work. In the present instance they were found to be very effective immediately after construction, but my impression is that, after the first winter, they became clogged and more or less unserviceable. At any rate, before similar ones are constructed elsewhere as public works, I should advise that the efficiency of these be thoroughly ascertained, which can be readily done by making openings in them at different points shortly after a rainfall. I think, that in place of these blind drains, tile drains of at least four inches diameter would have answered much better.

On the whole this work of drainage may be pronounced a success, it being now possible after very heavy rains to walk easily all over where, under similar circumstances, it was formerly covered with water. Its efficiency is also proved by the fact that the little stream which enters at the extreme end of the northern branch becomes entirely dry in midsummer, while at the outlet of the main drain there is always a very considerable flow.

The actual cost of this entire improvement was $12,353.77, approximately $269 per acre of swamp reclaimed, or $21 per lot.*

The cost of the main drains, exclusive of blind drains, was about $10,093, or $219 per acre.

Had they been entirely covered it would have been increased to $10,551, or $229 per acre.

I have indirect testimony from a physician, supposed to have the greatest amount of practice in the vicinity of this drainage, that it has had a marked effect in the decrease of malarial diseases; while on the other hand, Dr. Henry R. Pratt, of West Farms, writes, that "a careful inquiry through Belmont, and my own observation, furnish no proofs that the drainage in Belmont has had any sanitary effect." He adds: "While the drain was being dug through Belmont, there was an increase in the number of malarial cases, which gradually subsided as the work was completed."

A good deal has been thoroughly accomplished by the Woodlawn Cemetery Association towards draining the large swamps on their property. The system pursued seems to be the construction of parallel stone box drains placed about forty feet apart, with intermediate tile drains in swamps, with intercepting box drains around the edges; and to substitute for the natural brooks, flowing from the swamps, large blind drains composed of natural boulders and having rapid descent. The elongated slough lying west of the N. Y. & Harlem R. R. will be partly filled in and drained next year, and the remainder soon after. Nothing has yet been done by the Association towards draining the two large swamps near the southern limits of their property.

But little can be done at present with the salt meadow portion of this water shed. It might be made available for cultivation by diking the channel of the Bronx and putting in tide gates, but its malarious influence would in all probability be increased thereby. The one effectual improvement will be to raise the level of the land, by filling in to at least a level of four or five feet above high water. This would cost at least $500,000—an amount the expenditure of which would be entirely unjustified by any present demand for real estate in the vicinity.

The salt meadow between Longfellow street and the Harlem river and Portchester R. R. should be somewhat filled in at once, and an intercepting drain built along its western margin. In its present condition it is undoubtedly malarious, receiving at different times both salt and fresh water, and at all seasons the polluted drainage from barnyard and pig-sty.

The most urgent necessity exists for the immediate drainage of the extensive swamps lying near and west of the village of West Farms, as far as Avenue St. John.

A large covered drain should be made to take the place of the stream lying between Locust avenue and Samuel street, and should pass by a deep cut under the village.

The principal obstacle to its construction would be certain ledges of rock; but even were the expense of cutting through them considerable, the drainage recommended would in all probability pay at once upon the investment, by opening up a large tract of comparatively smooth land which could then have all other public improvements promptly effected at a minimum cost, rendering it very desirable and available for purchasers with small means.

A small locality at the southeastern corner of the Kingsbridge road and the southern boulevard particularly needs attention in the way of drainage.

There is a wet region on the Lorillard property along Mallow street which should be drained as soon as practicable, in order to improve the sanitary condition of Jerome Park station.

The swampy bottom lands between the Bronx River and the N. Y. & H. R. R., from Williamsbridge station south to Glencoe street, needs an extensive scheme of improvement in the way of drainage and filling. The vicinity is but little settled, and will probably remain so as long as this malarious spot exists.

The removal of the dam on the Lorillard place would greatly facilitate, if not entirely effect, the drainage of these bottom lands.

In order to do away with the swamp at the intersection of Willard avenue and Second street, and the wet ground east of Woodlawn Heights, the small stream which supplies the ornamental sheet of water at the northeast corner of Woodlawn Cemetery requires temporary improvement, at least; probably it should be replaced by a covered drain before it reaches the cemetery.

In connection with the drainage of this watershed comes up the closely allied one of its sewerage. The latter will constantly and rapidly gain in importance with increased settlement. Ultimately a large intercepting sewer will have to be constructed along the western bank of the Bronx River to take all the sewage of this district and carry it to Long Island Sound. This, however, will be an expensive undertaking, and one that will not be warranted for quite a number of years to come. Until it is built, the only possible disposition of this sewage will be to discharge it directly into the Bronx River. As far above the mouth as the morocco factory, the tide rises and falls (about six feet at the latter point), and the channel will in consequence be constantly kept scoured. Above the dam, at the morocco factory, the water is altogether fresh, and in summer and during seasons of drouth the current is greatly reduced, the mills near West Farms being obliged to resort to auxiliary steam power for two or three months each year.

In consideration of these facts it seems a misfortune that any portion of the natural flow of this river should be intercepted above the city line for the sake of obtaining, at a heavy expenditure, an addition to the water supply of the city, which can only defer but a very few years, the necessity of squarely facing the question of an adequate additional supply.

With the greatest estimated flow through the Bronx during the dryest season, about 511,104 cubic feet per diem—an amount which, assuming the stream to be twenty feet in width on an average from Kensico to tide-water—would give a depth of only three inches, if standing at a uniform depth throughout. It will soon be barely possible to prevent it becoming a nuisance in dry seasons, owing to the factories along its banks and the sewage necessarily emptied into it; particularly will this be the case as the eastern bank of the Bronx lies beyond city limits, and hence beyond municipal control.

* The actual assessment per lot will be much less, as the area considered to be benefited, and hence assessed, extends considerably beyond the limits of the swamp.

Then when 24 per cent. of the above stated flow is taken away for purposes of water supply, it cannot be disguised that it will greatly tend in summer to become simply an elongated open cesspool, and the source of great danger to all living near it.

I should recommend that legislation be applied for, which would give to this city jurisdiction over the eastern bank of the Bronx from Woodlawn to tide-water, at least so far as to control the class of occupation. It will naturally attract a very undesirable class of factories; that is, those seeking it not for power, but for dyeing, scouring and other chemical uses, excessively polluting in their tendencies.

I am strongly impressed with the belief that the true plan would be to keep a strip along the eastern or Westchester bank of the Bronx reserved as a public park, wherever parks are designed for the western or New York side. This stream can never be done away with, and is naturally singularly beautiful where it passes through the Lorillard and Lydig estates, and its banks can easily and with but little cost be kept as a healthful and charming pleasure ground. On the other hand, it will take but a few mistakes to totally pervert it into an eyesore and a nuisance.

As to the legislation required to practically accomplish the proper drainage and sewerage of the Twenty-third and Twenty-fourth wards, I would particularly ask for a serious consideration of the suggestion made at the close of that portion of my report devoted to general recommendations as to the proper sewerage and drainage of the district (p. 39). The change there proposed may seem radical, but I believe fully that for the annexed district it would be found perfectly practicable. It would certainly be in the interest of economy. There would be no assessments levied for sewers, hence none would be vacated, while a regular and increasing income would result to the city.

Chapter 360 of the Laws of 1880 should be at least amended so that the original location of drains within the district specified by the Board of Health as requiring to be drained, should be made by the department charged with making plans for, and building the drains after a right of way has been acquired.

Among the recommendations relating to the Tibbet's Brook and Bronx River water sheds is, that certain legislation be obtained to protect the head waters of the former, lying in Yonkers, from pollution (p. 41), and that this city obtain at least sanitary control over the eastern bank of the Bronx.

Very respectfully submitted,

E. B. VAN WINKLE,
Topographical Engineer, D. P. P.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The City Council of Bradford, Pa., bought of the Bradford Water-works Company the property and franchise of the company in fee simple, paying $19,400 therefor.

KINGSTON, Can., Aug. 16.—The question of supplying the city with water from Loughboro Lake is being considered by a committee appointed by the City Council, it being alleged that the present water-works company's charges are exorbitant.

The new water-works scheme under discussion at Peterboro, Canada, provides that the town subscribe one-half of the capital of $40,000, the other stockholders of the company subscribing the other half; the town to be represented on the Board by one director out of five.

CANTON, O., Aug. 16.—The City Council passed a resolution last night to appropriate $10,000 for the purpose of building a water-works reservoir near the present pumping station, west of the city. The water supply will be obtained, as heretofore, from Sprankle's dam.

Certificates authorizing the formation of a company to supply the town of New Lots, N. Y., with water have been filed in the office of the King's County clerk. It is proposed to fix the capital stock of the company at $250,000, in 2,500 shares.

The people of Paterson are alarmed at the action of the Newark authorities, and have appropriated $1,000 to procure analytical proofs that the 17,000,000 gallons of sewage thrown in the Passaic daily by Patersonians does not pollute the water supply of Newark, owing to the distance traveled before the stream is tapped by the Newark Aqueduct Board.

The Great Barrington, Mass., gas company find their recent change from coal to petroleum gas quite satisfactory. A new tub, holding 10,000 feet, is to replace the old one, which is decayed, and an iron tank, with a capacity of 5,000 gallons, is to be built. It will be 30 feet long and located near the railroad, so that the crude petroleum can be siphoned from the car directly into the tank.

Phillipsburg, Pa., has organized a company for the purpose of introducing water. A large reservoir will be placed on the hilltop, at an elevation of 150 ft. above the creek. The water will be taken from the Cold Stream flowing from the springs in the mountain. It will be forced to the reservoir with hydraulic pumps worked by a turbine water-wheel, thus saving expense of steam machinery. They are now engaged laying four miles of pipes through the streets, and will put in fire plugs all through the town.

The City of Atlanta, Ga., has ordered of the Holly Manufacturing Company, of Lockport, N. Y., a Holly quadruplex compound condensing pumping engine of 4,000,000 gallons daily capacity against a head, for domestic uses, of 265 feet, with three 5 × 16-foot tubular boilers, which, with the Holly engine and boilers now in use, will increase the pumping power to 6,000,000 gallons daily. The new engine is guaranteed to show 75,000,000 foot-pounds duty, and is to be completed March 1 next.

ELECTRICITY.

On the 16th the Brush Electric Light Company's proposal to light Hoboken for $9,000 for five years was laid over for a week at the meeting of the Common Council, and it will probably be accepted at the next meeting of the Board.

LONDON, Aug. 13.—The *Saturday Review*, speaking of the electric exhibition at Paris, says: "Leaving out of the question the fact that electricity as a science owes more to England than to any other nation, we cannot help stretching a point or two to claim for ourselves the highest place in its practical application. Cook and Wheatstone are undoubtedly Englishmen, and Sir Wm. Thompson is a Scotchman. Bell, though a naturalized American citizen, is a Scotchman by parentage, and we claim him. Professor Hughes, though an American, is domiciled in England, and despising logic, we claim him also. Without wishing to disparage Edison's work, there is no doubt that Swan, who is an Englishman, is the originator of practical lighting by incandescence."

BRIDGES.

Work has been commenced on the new bridge over the canal at Dunville, Canada.

The work of raising the Grand Trunk bridge at Napanee eighteen inches to the level of the track on either side has been completed.

The *Engineer* of July 22 says: "Bridges and structural iron work are still to be bought at the low rate of from £12 to £15 per ton, but the movement downwards to ruinous prices, which last year had become so serious, has been retarded by the failure of some of the weaker firms, who competed most recklessly. The orders from the India state railways are not so numerous or extensive as they have been for the last few years, but some more bridges of very large span are projected, and are likely soon to be carried out. Bridges for Canada, South Africa and Australia are being ordered, those from the latter colony coming frequently through local contractors, with whom it seems the policy of the authorities to deal, instead of always through the agents of the colonies in England."

RAILROADS.

The Missouri Pacific is constructing 175 miles of branches, viz.: Lexington and Southern, 70 miles; Laclede & Crève Cœur Lake, 13; Jefferson City, Lebanon & Southwestern, 40; Atchison, Colorado & Pacific, 50 miles.

The Reading Railroad Company laid 13,540 tons of new rails on their tracks in 1880, taking out 12,838 tons of old ones. The cost of the former being $54.61 and the price received for the latter $31.28, the expense for renewal was $337,809.23.

Track laying on the Canadian Pacific line, between Winnipeg, Manitoba and Portage la Prairie will be commenced on Monday. Four engineering parties have started to locate the Souris branch of the Canadian Pacific, from Brandon to the Souris coal fields.

From one of the levelmen on the G., St. L. & P. Ry., we received the following item: "The line of the G., St. L. & P. Ry., which is now being located from Boulder City to Middle Park, crosses the Snowy Range at an elevation of 11,925.97 ft. How is that for altitude?"

A Chicago dispatch, of the 14th, says: The new extension of the Quincy, Missouri & Pacific Division of the Wabash Railroad, from Milan to Trenton, Mo., was opened to passenger traffic to-day. The telegraph line along the route will soon be in operation. The wires are already strung from Kirksville, Mo., to West Quincy, and will be brought across the bridge to-day. The telegraph gang are now at work carrying the line westward from Kirksville to Milan and Trenton, and the whole distance will be ready for use in a few days.

A Denver, Col., dispatch says that a report is current that the Denver & Rio Grande and Chicago, Burlington & Quincy companies have arranged to build together the Burlington & Missouri road into Denver. The end of the Burlington & Missouri road is now about 200 miles from Denver. It is also said that the two above companies have formed a closer and permanent alliance and will make their Utah extension in common to Ogden, there connecting with the Central Pacific, thus making another through line from Chicago to San Francisco via Denver.

A letter from Winnepeg, Manitoba, says: "The main line of the Canadian Pacific Railway has been completed to 33 miles west of Portage la Prairie, to which point trains now run daily. Brandon will be reached by Sept. 15. Superintendent Stickney has given the following order for rolling stock: 1,000 flat cars, 350 box cars, 200 stock cars, 30 cabooses, 15 first-class cars, 14 second-class cars, 14 baggage cars, 40 locomotives, 2 tool cars, 1 pile driver, 3 sleepers and 2 derricks. Contracts for grading, amounting in the aggregate to about $300,000, have been let to the main line west within the last few days. The southern extension is now under way from Scratching River to the international boundary, and the Pembina Mountain branch is under contract as far west as Calf Mountain. There are already 250 men and 150 teams at work on these branches. Before snow flies the Canadian Pacific Railway Company will have completed 400 miles of new road, including main line and branches."

A dispatch from St. Johns, dated Aug. 16, says: The New York & Newfoundland Railway Company formally commenced the work of railroad construction in this island to-day. Shortly before noon the first sod was turned under the management of Mr. Bolland, an engineer of European reputation, and several squads of navvies are now busily engaged in grading those sections of the road that had been previously located. The two termini of the railroad are St. Johns on the south and the north shore of Notre Dame Bay on the northerly end. Concurrently with the inauguration of the railway work in St. Johns there is reported from undoubted sources a gold find of extraordinary promise at Mings Bight, close to the very spot where the New York Company, at least for the present, purposes terminating their line. The vein ranges from 10½ to 12 in. in breadth on the surface and widens considerably as it descends. It has been found by the assayer to yield 18 oz. of pure gold to the ton of ore, and, so far as explorers have ascertained, the vein preserves an unbroken continuity for several miles. The proposed 400 miles of railroad now actually begun run through the whole of the principal metalliferous belts of the island, and the capitalists of New York who have secured this golden contract with the Newfoundland government will daily discover to their extreme satisfaction, as the work progresses, that in their eight mile alternate blocks along the whole line of railway they have secured mines of rich, rare and undoubted wealth, from which the means of building a half dozen Newfoundland railroads such as the one contemplated can be obtained. The Premier of Newfoundland and Mr. Blackman, the manager of the New York Company, are now in London, and will leave for St. Johns by the next Allan steamer. Mr. Blackman will then proceed without delay to New York, and there organize and dispatch to St. Johns several corps of engineers for the immediate location of the whole line. The work of construction is now calculated to be brought to completion within two years.

RIVERS AND HARBORS.

A party of surveyors are taking levels of Lake Manitoba to ascertain the possibility of draining its waters into Lake Winnipeg.

It has lately been discovered that the harbor at New Buffalo, on Lake Michigan, can be made in all respects one of the most excellent on the lakes. A movement is is now on foot, headed by Congressman Burrows, to secure the necessary appropriation from Congress, and $50,000 will be asked for. The leading business men in that section of the State seem to be in earnest in this matter, and they are assured by Mr. Burrows that the appropriation will certainly be made. Railroad corporations in the northern portion of Indiana will be interested in this matter, and should keep a careful watch in this direction, as some of their neighbors will be soon slipping into New Buffalo with a new road.

NEW PROJECTS.

It is proposed to build an extension of the Chesapeake & Ohio and Scioto Valley road from Columbus, through Delaware, Bellefontaine and Wapakoneta, O., to Fort Wayne, Ind., and thence to Chicago. The old roadbed (which is graded) of the Bellefontaine & Delaware railroad will be used. This will make the most direct route from Chicago to the seacoast, and it is believed that the scheme will be carried out.

Articles of incorporation of the Lake Superior & Dakota Railway Company have been filed with the Secretary of State of Minnesota. The purpose is to construct in as nearly a direct line as possible a railroad from Duluth to a point on the Red River of the North north of the eleventh standard parallel, with a branch line to the boundary between Wisconsin and Minnesota. The capital stock is fixed at $5,000,000, and the names of the incorporators are I. Herbaugh, C. K. Davis, J. A. Stewart and C. W. McIntyre, St. Paul; R. Fairweather, William Anglim and Frank Ives, Cookston, and M. Graves and Charles Lockwood, Pittsburgh, Pa.

CONTRACTING, MISCELLANEOUS, ETC.

Georgia is to have a new $1,000,000 State capitol building.

Commissioner Waller, of Chicago, is of the opinion that the Washington street tunnel will not be repaired, and that it is only a question of time when it will be closed and a double bridge built over the river at that point.

Steel rails are still very active, and large sales are reported for 1882 delivery. Prices continue to be quoted at $55 to $60 per ton at mill according to time of delivery. English steel rails are active, and are quoted at $59 to $62, according to point of delivery. Old iron rails are quoted $26.50 to $27 per ton in Philadelphia, with a very light demand.